

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application for:

AUTOPROGRAMMING FOR DIGITAL TELEVISION

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Docket Number: SNY-N3783.01

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6 **AUTOPROGRAMMING FOR DIGITAL TELEVISION**

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8 **CROSS REFERENCE TO RELATED DOCUMENTS**

9 This application is a division of co-pending U.S. Serial Number 09/576,878
10 filed May 22, 2000 which is hereby incorporated by reference.

11
12 **FIELD OF THE INVENTION**

13 This invention relates generally to the field of Digital Television (DTV), also
14 referred to as Advanced Television (ATV). More particularly, in certain preferred
15 embodiments, this invention relates to a method and system for tuning an ATSC
16 (the Federal Communication Commission's Advanced Television Systems
17 Committee) compliant digital television for both PSIP (the ATSC's Program System
18 Information Protocol) and MPEG 2 (Moving Picture Expert Group version 2) digital
19 video broadcast format video.

20
21 **BACKGROUND OF THE INVENTION**

22 In the United States, digital television signals can be broadcast using either
23 of two technical standards. The first is MPEG 2 which is mandatory. The second
24 is PSIP which is an optional standard that supports enhanced features. The PSIP
25 standard provides the ability to associate multiple channel frequencies with a single
26 broadcaster for display in the channel guide. The MPEG 2 digital video broadcast
27 standard provides no such capability. For MPEG 2, the major channel displayed
28 in the program guide corresponds directly with the physical channel number
29 (frequency) used to broadcast the digital television signal. For PSIP broadcasts,

1 programming can be broadcast on multiple frequencies yet displayed as a
2 collection of major and minor channels in the program guide for ease of selection
3 by the user. That is, for PSIP, a virtual channel number can represent the physical
4 channel carrying the broadcast whereas in MPEG 2, the concept of a virtual
5 channel does not exist - the major channel number is always the physical channel
6 number associated with a broadcast frequency.

7 These two differing standards create a challenge for design of the digital
8 television receiver. Since each format PSIP and MPEG uses its own Program
9 Specific Information tables as defined in the respective specifications, the television
10 receiver device must be able to distinguish between the two formats and use the
11 Program Specific Information so that the receiver can receive both the PSIP and
12 MPEG standard program formats in a manner which is transparent to the user.

13 14 **SUMMARY OF THE INVENTION**

15 The present invention relates generally to digital television. Objects,
16 advantages and features of the invention will become apparent to those skilled in
17 the art upon consideration of the following detailed description of the invention.

18 In one embodiment consistent with the present invention a method of tuning
19 a digital television receiver includes receiving a command to tune to a major
20 channel and a minor channel; determining whether the major channel is PSIP
21 compliant, and if so: looking up a TSID corresponding to the major channel; looking
22 up a physical channel corresponding to the TSID; tuning a tuner to the physical
23 channel; and determining if the physical channel carries the major and minor
24 channel, and if so, remaining tuned to the physical channel.

25 In another embodiment consistent with the present invention, a method of
26 storing channel information in a digital television receiver, includes tuning to a
27 selected physical channel; reading Program Specific Information on the selected
28 physical channel; storing an indication of whether the physical channel is a PSIP
29 compliant channel; if the selected physical channel is a PSIP compliant channel:

1 storing a TSID corresponding to the selected physical channel; and storing a major
2 channel corresponding to the selected physical channel.

3 In another embodiment consistent with the present invention, a method of
4 autoprogramming channel information in a digital television receiver, includes for
5 each of a plurality of N physical channels: tuning to a selected physical channel;
6 reading Program Specific Information on the selected physical channel; storing an
7 indication of whether the physical channel is a PSIP compliant channel; if the
8 selected physical channel is a compliant PSIP channel: storing a TSID
9 corresponding to the selected physical channel; and storing a major channel
10 corresponding to the selected physical channel.

11 A device for tuning a digital television receiver consistent with another
12 embodiment of the present invention includes a control module. A user module
13 provides an interface to a user and sends commands to the control module to
14 select a major and minor television channel. A tuner tunes to physical channels
15 and produces a digital transport stream of packets. A database stores Program
16 Specific Information from a currently tuned physical channel. A demultiplexer
17 receives the transport stream and produces a demultiplexed data stream
18 representing a tuned television channel. The control module includes program for:
19 determining whether the major channel is PSIP compliant, and if so: looking up a
20 TSID corresponding to the major channel; looking up a physical channel
21 corresponding to the TSID; tuning a tuner to the physical channel; and determining
22 if the physical channel carries the major and minor channel, and if so, remaining
23 tuned to the physical channel.

24 25 **BRIEF DESCRIPTION OF THE DRAWINGS**

26 The features of the invention believed to be novel are set forth with
27 particularity in the appended claims. The invention itself however, both as to
28 organization and method of operation, together with objects and advantages
29 thereof, may be best understood by reference to the following detailed description

1 of the invention, which describes certain exemplary embodiments of the invention,
2 taken in conjunction with the accompanying drawings in which:

3 **FIGURE 1** is a block diagram of a tuning and autoprogramming system for
4 a digital television receiver (or set top box) in accordance with an embodiment of
5 the present invention.

6 **FIGURE 2** is an illustrative simplified programming guide.

7 **FIGURE 3** is a flow chart of an autoprogramming process consistent with
8 certain embodiments of the present invention.

9 **FIGURE 4** is a flow chart of a process for updating the autoprogramming
10 tables in accordance with an embodiment of the present invention.

11 **FIGURE 5**, which is made up of **FIGURE 5A**, **FIGURE 5B**, **FIGURE 5C** and
12 **FIGURE 5D** is a flow chart of a channel selection process consistent with certain
13 embodiments of the present invention.

14 15 **DETAILED DESCRIPTION OF THE INVENTION**

16 While this invention is susceptible of embodiment in many different forms,
17 there is shown in the drawings and will herein be described in detail specific
18 embodiments, with the understanding that the present disclosure is to be
19 considered as an example of the principles of the invention and not intended to limit
20 the invention to the specific embodiments shown and described. In the description
21 below, like reference numerals are used to describe the same, similar or
22 corresponding parts in the several views of the drawing.

23 Before describing the current invention in detail, it is useful to define several
24 of the terms which will be used frequently herein. The term "physical channel" as
25 used herein refers to a broadcast frequency used to transmit digital television
26 programming. In the United States, 68 physical channels are utilized to broadcast
27 digital television. These channels are numbered 2 through 69. The physical
28 channel for broadcasting any particular program can vary from location to location
29 so that the same program might be carried on a different physical channel

1 depending upon the channel assignment available to local television station. The
2 term "virtual channel" and "major channel" refer to identifiers which typically identify
3 a network or source of programming material such as CBS, ABC, NBC, Fox, etc.
4 The major channel or virtual channel is represented by a major channel number
5 which is used by the television receiver to partially identify a television program.
6 The term "minor channel" is a number which used in conjunction with the major
7 channel number uniquely identifies a television program. For example, a user
8 could tune to channel 2.4 which would indicate major channel 2 minor channel 4
9 and this channel would uniquely identify a television program. The term TSID or
10 "Transport Stream Identifier" is a number which identifies a transport stream carried
11 on a particular physical channel. The TSID to transport stream association is
12 unique for each transport stream that carries PSIP information; but, it is not
13 necessarily unique for MPEG 2 only transport streams. Thus, two different PSIP
14 transport streams will not have the same TSID value, but two MPEG 2 only
15 transport streams might. Moreover, a PSIP transport stream and an MPEG 2
16 transport stream might share the same TSID value.

17 A "program" is defined to generally mean the conventional meaning of a
18 program in the television sense, but a program in digital television is made up of
19 a collection of program elements such as audio elementary streams, video
20 elementary streams, etc. A transport stream may contain several programs
21 multiplexed together if the physical channel bandwidth will support it. For example,
22 MPEG 2 channels 24.1 and 24.2 may share a single transport stream. Finally, a
23 "Packet Identifier" or PID is used to identify each element (packet) in the transport
24 stream with a particular program. Therefore, packets associated with a particular
25 channel will always use a common PID. Each elementary stream is associated
26 with a PID and this association is given by the Program Specific Information
27 present in the transport stream (and stored in a database in the present invention
28 for the currently tuned physical channel as will be explained later.)

29 Referring now to **FIGURE 1**, the architecture of a DTV Control System in
30 accordance with an embodiment of the present invention is shown as 100. This

1 embodiment may form a part of a digital television set itself, a digital television
2 adapter or a set-top box (STB), or any other device including DVD players and video
3 cassette recorders which incorporate an internal tuning mechanism. The above
4 architecture is used to tune digital television broadcasts. A DTV control module
5 104, which is based upon a programmed processor such as the Trimedia
6 processor produced by Phillips, Inc. in the present embodiment, provides the
7 intelligence for the DTV tuning system of the present invention. DTV control
8 module 104 interfaces with a user module 108 which provides a user interface to
9 the system 100.

10 User module 108 may incorporate a graphical user interface, remote
11 controller interface and/or any other suitable mechanism for interfacing with a user.
12 Commands issued by the user are translated by the user module 108 into a DTV
13 command message 112 destined for the DTV control module 104. DTV control
14 module 104 issues acknowledgments and error codes 116 back to the user module
15 108 along with a unique identifier code for each command 112 which is being
16 acknowledged by an acknowledgment 116. This unique identifier is used so that
17 if multiple commands are issued by the user, only the latest user command is used
18 by the user module 108 to report status etc. to the user. Progress in completion of
19 any commands by the DTV control module 104 is recorded as a DTV progress
20 message 118 back to the user module 108. Such progress messages may be
21 translated into reports to the user or may simply be used internally by the user
22 module 108.

23 When the DTV control module 104 is instructed to select a physical channel
24 by a command 112 from the user module 108 or by an internal routine, a physical
25 channel select command 128 is sent to a tuner module 130. The tuner module
26 receives input signals representing the physical channels 2 through 69 and
27 demodulates the selected channel to produce a stream of packets of digital data
28 referred to herein as transport stream 134. Each transport stream has a transport
29 stream identifier or TSID, and each packet has a packet identifier or PID which
30 correlates to a program component (or elementary stream).

1 Upon receipt of the physical channel selection command 128, the tuner
2 module 130 acknowledges or sends an error code 138 back to the DTV control
3 module 104 to indicate receipt of the command or an error. Upon completion of the
4 process of selecting the particular physical channel and settling of all transients
5 associated therewith, a tuning complete status signal 140 is sent from the tuner
6 module 130 to the DTV control module 104.

7 In accord with the ATSC standard, the transport stream 134 may carry
8 multiple programs residing on a single physical channel. These programs are
9 demultiplexed in a demultiplexer 146 in accordance with a packet identifier (PID)
10 selected by DTV control module 104 by a command issued on line 150. The
11 packet identifier is determined by the digital television specification and can be
12 programmed within the digital TV control module 104. Transport stream status
13 information 154 is provided to the DTV control module 104 from demultiplexer 146.

14 One of the advanced features of digital television is the ability to provide
15 program guide information for display by the user on his television set. This
16 information is available in transport stream 134 as a part of the "Program Specific
17 Information" tables for the currently tuned physical channel. As this Program
18 Specific Information is received by demultiplexer 146 relevant data are stored in a
19 database 158 for the currently tuned physical channel. When the database 158 has
20 been fully updated for a newly tuned physical channel, an update signal 160 is
21 transmitted from the database 158 to the digital TV control module 104 to provide
22 the module with notification that the database 158 has been updated. DTV control
23 module 104 may then issue queries 164 of database 158 and receive query results
24 170 from the database 158 to ascertain information about the currently tuned
25 physical channel. Whenever a new physical channel is tuned by the tuner module
26 130, the database 158 is reset and repopulated with data from the newly tuned
27 physical channel's Program Specific Information tables.

28 Referring to **FIGURE 2**, a simple example of a program guide as might be
29 displayed on the user's television set is illustrated as 200. The first block of
30 programs shown as CBS 4 represent a collection of minor channels 1, 2 and 3.

1 associated with three different television programs all of which use virtual channel
2 or major channel 4. The second collection of programs referred to as PBS 24 show
3 two programs which are associated with two minor channels forming a part of
4 major channel 24.

5 By way of example, when any one of minor channels 1, 2 or 3 of major
6 channel 4 is tuned by the tuner module 130 and demultiplexer 146, the database
7 158 captures the transient information associated with the tuned physical channel.
8 In the case of major channel 4, in this example assume major channel 4 is a PSIP
9 channel with data shown in **TABLE 1**. In addition to including television show
10 name, rating, closed captioning information as well as a description of the
11 programming and other useful information, the Program Specific Information
12 includes the information shown in **TABLE 1** which relate major plus minor channel
13 to a physical channel and a TSID. Since three different physical channels are
14 associated with the major channel (virtual channel) 4, this is clearly a PSIP format
15 broadcast stream. Only one program is present on this physical channel, and it is
16 uniquely identified within the transport stream by the TSID and the PID obtained
17 from the Program Specific Information stored in the database 158 for the currently
18 tuned channel.

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DATABASE DATA / TRANSPORT STREAM SYSTEM DATA			
MAJOR CHANNEL	MINOR CHANNEL	PHYSICAL CHANNEL	TSID
4	1	57	381
4	2	16	101
4	3	12	122

21
22
23
24
25
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27
28

TABLE 1

1 In order to tune to any given television program as identified by major plus
2 minor channel (either by direct selection by the user or by incrementing up or down
3 to the next channel or any other mechanism which ultimately delivers a major plus
4 minor channel to the DTV control module 104) the DTV control module 104
5 associates the major channel and minor channel with a physical channel and
6 packet ID (PID) in order to tune to the channel. The present invention utilizes an
7 autoprogramming function to populate three static tables which are stored in non-
8 volatile memory (for example flash memory) so that during the channel selection
9 process the digital TV control module 104 may ascertain how to tune tuner module
10 130 to any particular selected program.

11 The static information (which rarely changes except during an
12 autoprogramming process) stored in the non-volatile memory in accordance with
13 one embodiment of the invention is stored in three tables shown as **TABLES 2, 3**
14 and **4** below and referred to respectively as the PSIP/MPEG Table, the Major/TSID
15 Table and the Physical/TSID Table respectively. Collectively, these tables are
16 referred to as the autoprogramming tables. The autoprogramming process in
17 accordance with an embodiment of the present invention is illustrated in **FIGURE**
18 **3** as process 300. This process generally is a process for systematically stepping
19 through each of the physical channels, tuning to the physical channels one by one
20 and extracting from the resulting database information for the currently tuned
21 physical channel (including major channel information and TSID information
22 associated with the major channel) from the Program Specific Information tables
23 in the transport stream 134. This information is stored in **TABLES 3** and **4** for all
24 PSIP channels, with **TABLE 2** providing a directory of PSIP vs. MPEG channels.
25 Recall that for MPEG channels, the major channel number is identical to the
26 physical channel and can be tuned directly.

PSIP / MPEG TABLE	
MAJOR CHANNEL	PSIP CHANNEL?
4	YES
24	NO
29	YES
39	NO
45	NO
56	NO

TABLE 2

MAJOR / TSID TABLE	
MAJOR CHANNEL	TSID
4	381
29	136

TABLE 3

PHYSICAL / TSID TABLE	
PHYSICAL CHANNEL	TSID
12	122
16	101
19	136
57	381

TABLE 4

1 Referring now to **FIGURE 3**, the autoprogramming process begins at
2 304 upon receipt of an autoprogram command by the DTV control module 104
3 issued as a DTV command 112 from user module 108 in response to a user
4 command to autoprogram or another event which automatically triggers an
5 autoprogram process. In the event an error occurs at 304, the process terminates
6 at 308 without further action except possibly issuance of an error message.
7 Assuming the command is received and can be executed at 304, an acknowledge
8 message 116 along with a unique command ID is sent from DTV control module
9 104 to user module 108 as acknowledgment 116 at 310.

10 At 314 the physical channel is set to the first physical channel (typically 2)
11 and control passes to 318. At 318 the DTV control module 104 sends a select
12 physical channel command 128 to tuner module 130 to select the currently
13 selected physical channel and start an autoprogramming timer. Control then
14 passes to 322 where the DTV control module 104 awaits either a tuner or a timer
15 event message. Under normal circumstances, a tuner event (a message 140
16 indicating completion of tuning to the selected physical channel by tuner 130) will
17 occur before the autoprogramming timer times out so that a tuner event is detected
18 at 326 via a tuning complete status signal 140. Upon receipt of the tuner event at
19 326, the database 158 is cleared with a reset and acquisition of new database
20 information for database 158 is commenced at 330. When the autoprogramming
21 timer expires at 334, enough time has passed for both the tuner 130 to acquire the
22 selected physical channel and the new information to have been completely
23 acquired at 330. At 334, the timer event has completed and the database
24 information is normally present. Thus, **TABLES 2, 3 and 4** can be updated at 340.

25 Assuming a valid physical channel was found and the tables were properly
26 updated at 340, the process of scanning the current physical channel is completed
27 at 342 and an appropriate report is set as a DTV progress message 118 from the
28 DTV control module 104 to the user module 108. In the event a signal was not
29 found at 326 (i.e. no physical channel information was present on the currently

1 tuned physical channel at 326) or no database information was found at the end of
2 the autoprogramming timer at 334, the tables are not updated at 340 and an error
3 report is generated at 342 indicating to the user module 108 that a valid channel
4 was not found. If the current physical channel is not the last physical channel
5 (usually channel 69) at 346, the physical channel is incremented at 350 and control
6 returns to 318 where the tuner selects the next physical channel and repeats the
7 process. If the physical channel was the last physical channel at 346, a report is
8 generated to user module 108 indicating that the autoprogramming process is
9 complete at 356 and the process terminates at 308.

10 Referring now to **FIGURE 4**, stage 340 of updating the **TABLES 2** through
11 **4** is described in greater detail. This process begins with querying of database 158
12 at 404 and first determining if the currently tuned physical channel is a PSIP
13 channel at 408. If not, the PSIP/MPEG Table (**TABLE 2**) is updated by indicating
14 that the currently selected channel is not a PSIP channel at 412. In this case, by
15 knowing that the channel is not a PSIP channel it must be an MPEG channel
16 therefore the major channel is equal to the physical channel, and further population
17 of **TABLES 3** and **4** is not needed.

18 In the event the currently selected physical channel is a PSIP channel at
19 408, the PSIP/MPEG Table (**TABLE 2**) is updated to indicate that the current major
20 channel is in fact a PSIP channel at 422. Control then passes to 428 where the
21 TSID is read from the database 158 for the currently tuned physical channel and the
22 Physical/TSID Table (**TABLE 4**) is updated. Control then passes to 434 where the
23 major channel for the current TSID is read from the database 158 and the
24 Major/TSID Table (**TABLE 3**) is updated. When 412 or 434 is completed, stage
25 340 has been completed and control passes to 342 of **FIGURE 3**.

26 Those skilled in the art will recognize that the relationship between TSID and
27 major channel as listed in **TABLE 3** is not a unique one-to-one relationship. In fact,
28 the relationship from major channel to TSID may be a one-to-many relationship
29 since a major channel as shown in **TABLE 1** may have, for example, three physical

1 channels and TSID's associated with major channel 4. For purposes of the present
2 invention, it is only important that one valid relationship is stored in non-volatile
3 memory which relates the major channel to one of the TSID's for the major
4 channel. As the process of **FIGURE 3** is implemented, it makes no difference
5 whether or not the Major/TSID Table (**TABLE 3**) is updated when a new TSID is
6 encountered for an existing major channel or whether the originally stored major
7 channel to TSID relationship is retained for those major channels having multiple
8 TSID's. It is only important that one valid major channel TSID relationship be stored
9 in **TABLE 3**.

10 In the example shown in **TABLE 1**, the autoprogramming process for major
11 channel 4 proceeds by first determining that the major channel 4 is a PSIP channel
12 and indicating adjacent the major channel 4 entry in **TABLE 2** that it is a PSIP
13 channel. Major channel 4 will first be encountered in the autoprogramming process
14 upon tuning to physical channel 12. Thus, the TSID for physical channel 12 will be
15 entered into **TABLE 4**. Next, **TABLE 3** will be updated with a TSID of 122 from
16 **TABLE 1** in **TABLE 3**. When physical channel 16 is encountered, it is again
17 determined to be a PSIP channel associated with major channel 4 which is already
18 in **TABLE 2**. **TABLE 4** is then updated with a TSID of 101 for physical channel 16
19 and **TABLE 3** may be updated from 122 as the TSID associated with major channel
20 4 to 101 as the TSID associated with major channel 4. When the physical channel
21 is finally tuned to physical channel 57, **TABLE 4** is updated to associate 381 as the
22 TSID for physical channel 57 and **TABLE 3** is updated to change the TSID
23 associated with major channel 4 to 381. In the above scenario, **TABLE 3** could
24 equally well have remained TSID 122 associated with major channel 4. As
25 previously mentioned, it is only necessary that there be a correct index from the
26 TSID to the correct major channel.

27 Once all of the above information is stored in **TABLES 2, 3 and 4**, the tuning
28 system 100 of **FIGURE 1** can be used to tune any desired program as selected
29 from a program guide such as **FIGURE 2** or alternatively selected by incrementing

1 the channel up or down or using any other selection technique. The information
2 stored in **TABLES 2, 3** and **4** is assumed by the system to be static information and
3 is stored in non-volatile memory. In the event of a change in any of this information,
4 a new autoprogramming sequence should be instituted to update the information
5 in order for the receiver to be able to continue to correctly receive the television
6 programming. Referring now to **FIGURE 5**, which is broken into **FIGURES 5A, 5B,**
7 **5C** and **5D**, the channel selection process in accordance with an embodiment of
8 the present invention is illustrated. In this process, starting at **FIGURE 5A**, the DTV
9 control module 104 receives channel selection information in the form of the DTV
10 command 112 from user module 108. This channel selection command includes
11 major and minor channel numbers. When this channel information is received at
12 502 by the DTV control module 104, the DTV control module 104 checks the static
13 non-volatile memory for **TABLES 2, 3** and **4** to determine if the major channel
14 selected is among those in the autoprogramming tables at 506. If not, the channel
15 selection command is acknowledged with an acknowledgment which includes a
16 command identifier and the user module 108 is notified by the DTV control module
17 104 that the command is invalid at 508. The process then terminates at 510.

18 If the major channel is in the autoprogramming tables at 506, control passes
19 to 512 where **TABLE 2** is consulted to determine if the major channel is a PSIP
20 channel or an MPEG 2 channel at 512. If it is an MPEG 2 channel at 512, the
21 physical channel is set equal to the major channel at 516 and control passes to
22 518. At 518 if the physical channel is equal to the current physical channel, at this
23 point an acknowledgment 116 is returned to user module 108 along with an
24 appropriate command identifier and a report that no acquisition is needed at 522.
25 Control then passes to the process of **FIGURE 5B** starting with the connector **B**.
26 If at 518, the physical channel is not equal to the current physical channel, an
27 acknowledgment message 116 is sent from the DTV control module 104 to the
28 user module 108 along with a report that acquisition is needed in order to tune to
29 the correct physical channel at 526. The tuner is then set for the correct physical

1 channel at 528 and control again passes to connector **B** and the process of
2 **FIGURE 5B**.

3 At 530 a channel selection timer is started and control passes to 532 where
4 a timer event or a database update event is awaited. In the event a database
5 update event occurs first at 534 and the major plus minor channel is not found at
6 534, control returns to 532 until the channel selection timer event occurs. When
7 the timer expires at 532, the timer event causes 538 to determine if the major plus
8 minor is in the database 158. If the major plus minor channel is in the database at
9 either 534 or 538, control passes to 540. In either event, at 540 the program packet
10 identifiers are enabled so that the DTV control module 104 selects the appropriate
11 packet identifier using 150 to extract the appropriate program from the transport
12 stream 134. At 542, a report and command identifier is sent to the user module
13 108 with the report indicating that the channel selection is complete and the
14 channel has been found. The channel selection process then terminates at 510.
15 In the event the major plus minor channel is not present in the database 158 at 538
16 upon expiry of the channel selection timer, control passes to 546 where a report
17 and command identifier is sent to the user module 108 from the DTV control
18 module 104 indicating that the channel selection is complete but the channel was
19 not found. The process then terminates at 510.

20 Referring back to **FIGURE 5A**, if the major channel is a PSIP channel at 512,
21 control passes to the process of **FIGURE 5C** beginning at connector **A**. At 550, the
22 TSID is determined from the major channel using the Major/TSID Table (**TABLE 3**).
23 Control then passes to 552 where the physical channel is looked up for the TSID
24 using the Physical/TSID Table (**TABLE 4**). Control then passes to 554 which
25 determines whether the physical channel is equal to the current physical channel.
26 If not, the process of **FIGURE 5D** is invoked as will be discussed later. If so, control
27 passes to 558 where the TSID associated with the current program including both
28 major and minor channels is obtained from the database 158. Since the current
29 physical channel is the physical channel desired, the most accurate up-to-date

1 information should currently be stored in database 158. Control then passes to 560
2 where the physical channel is determined for the TSID from the Physical/TSID
3 Table (**TABLE 4**).

4 If the physical channel determined from the Physical/TSID Table in 560 is
5 equal to the current physical channel at 562, the channel selection is
6 acknowledged and the command ID is forwarded from the DTV control module 104
7 as an acknowledgment 116 to the user module 108 along with a report that no
8 acquisition is needed at 564. Control then passes to the process of **FIGURE 5B**
9 at connector **B**. In the event the physical channel is not equal to the current
10 physical channel at 562, control passes again to connector **C** of **FIGURE 5D**.

11 Referring now to **FIGURE 5D**, the process beginning with connector **C** is
12 illustrated beginning with an acknowledgment message 116 which is sent from the
13 DTV control module 104 to the user module 108 along with a command ID and a
14 report that acquisition is needed to tune to the selected channel at 568. At 572 the
15 tuner is set for the physical channel determined at either 552 or 560 of **FIGURE 5C**.
16 The channel selection timer is started at 574 and control passes to 576 where a
17 database update event or a timer event is awaited.

18 When a database update event is received, and the selected major plus
19 minor channel is not in the database 158, control returns to 576 to await another
20 database update event or a timer event. In the event of a timer event at 580 if the
21 major plus minor channel is now in the database 158, control passes to 582.
22 Control also passes from 578 to 582 in the event the major plus minor channel is
23 found in the database 158. Control then passes to 584 where the physical channel
24 is determined for the TSID from the Physical/TSID Table. If the physical channel
25 is not equal to the current physical channel at 586 control returns to 572 where the
26 tuner is reset for the physical channel. If the physical channel is equal to the
27 current physical channel at 586, the PID's are enabled for selection at 150 to
28 extract the appropriate program from the transport stream 134 at 588. Control then
29 passes to 590 where a report including a command identifier is sent from the DTV

1 control module 104 to user module 108 along with a report that the channel
2 selection is complete and the channel has been found at 590. The process then
3 terminates at 510.

4 In the event at the end of the channel selection timer the major plus minor
5 channel is not found in the database 158 at 580, a report and command ID is sent
6 from the DTV control module 104 to the user module 108 at 596 indicating that the
7 channel selection is complete, but the channel is not found. The process then
8 terminates at 510.

9 In the above scenario, if the user was tuning to channel 4.1 instead of 4.2
10 physical channel 57 would have been the correct channel initially and an iteration
11 of the tuning process would not have been necessary. In the event the user wished
12 to tune to channel 24.1, the DTV control module 104 would ascertain from **TABLE**
13 **2** that the major channel 24 is not a PSIP channel but is in fact an MPEG 2
14 channel. Thus, the physical channel is set equal to the major channel and physical
15 channel 24 is tuned by the tuner module 130. The data stream then associated
16 with minor channel 1 of major channel 24 is simply extracted from the transport
17 stream 134 by a demultiplexer 146 using the appropriate PID in order to select the
18 program associated with channel 24.1.

19 In accordance with the above invention, if the user wishes to tune, for
20 example, to channel 4.2, the DTV control module 104 determines from the
21 PSIP/MPEG Table that major channel 4 is a PSIP channel. The major channel is
22 then determined from the Major/TSID Table to have a TSID of 381. TSID 381 is
23 then determined from the physical TSID Table to be associated with physical
24 channel 57. The tuner module 130 is thus directed by the DTV control module 104
25 to tune physical channel 57.

26 Once channel 57 is tuned, the DTV control module 104 determines from the
27 database 158 that program material for minor channel 4.2 is not present. Recall
28 that minor channel 4.2 as shown in **TABLE 1** is physical channel 16 with TSID 101.
29 However, since physical channel 57 is a part of major channel 4 all of the

1 information of **TABLE 1** is available in database 158 once the physical channel has
2 been tuned to any of the physical channels associated with major channel 4. Thus,
3 the DTV control module 104 is able to ascertain from the database 158 that
4 channel 4.2 actually has a TSID of 101 and is associated with physical channel 16.
5 Accordingly, the DTV control module 104 instructs tuner 130 to tune to physical
6 channel 16. Upon completion of the tuner module 130 tuning to physical channel
7 16, the demultiplexer 146 is able to extract the program material associated with
8 the packet identifier (PID) for major channel 4.2 from the transport stream 134 and
9 the tuning process is complete.

10 Once the program is playing, the DTV control module 104 monitors the
11 database 158 for any significant changes. Every time the content of database 158
12 is modified, an update message is sent to the DTV control module 104. The DTV
13 control module 104 then queries the database 158 and compares the new data
14 with the old one. The DTV control module 104 then makes the appropriate
15 changes (new elementary PIDs, new content rating, new caption descriptor, new
16 event, etc...) and notifies the user module 108 if needed. The multiplexer 146
17 and/or tuner module 130 also notify the DTV control module 104 in case there is
18 any change in the input signal status (signal lost, bad synchronization, errors, etc.).
19 If the signal is lost, the DTV control module 104 resets the database 158, notifies
20 the user module 108 and waits for the signal to be acquired again or for the user
21 to issue another DTV command 112.

22 Those skilled in the art will recognize that there are other mechanisms for
23 implementing the processes described above. For example, rather than using 3
24 tables (**TABLES 2** through **4**) each having two columns, a single table as illustrated
25 below as **TABLE 5** can be utilized to carry all of the information of **TABLES 2, 3**
26 and **4** in a single table with four columns.

AUTOPROGRAMMING TABLE (SECOND EMBODIMENT)			
MAJOR CHANNEL	PSIP?	TSID	PHYSICAL CHANNEL
4	YES	122	12
4	YES	101	16
4	YES	381	57
24	NO	-	24
29	YES	136	19
39	NO	-	39
45	NO	-	45
56	NO	-	56

TABLE 5

Those skilled in the art will recognize that the present invention has been described in terms of exemplary embodiments based upon use of a programmed processor forming a part of the DTV Control Module 104. However, the invention should not be so limited, since the present invention could be implemented using hardware component equivalents such as special purpose hardware and/or dedicated processors which are equivalents to the invention as described and claimed. Similarly, general purpose computers, microprocessor based computers, micro-controllers, optical computers, analog computers, dedicated processors and/or dedicated hard wired logic may be used to construct alternative equivalent embodiments of the present invention.

Those skilled in the art will also appreciate that the architecture disclosed herein is exemplary. Other architectures which divide the functionality of a module and/or combine the functionality of the modules will occur to those skilled in the art and are contemplated as equivalents to the presently disclosed architecture.

The present invention may be modified in many ways without departing from the present invention. For example, as disclosed above, the autoprogramming

1 tables are only modified during the autoprogramming process. If any of the table
2 values are changed after the last autoprogramming, the DTV control module 104
3 might not be able to tune correctly to the channel. The only message displayed in
4 that case is "No Program". However, in an alternative embodiment, when tuning
5 to such a modified physical channel where the signal is present, it is possible to
6 detect inconsistencies between the autoprogramming tables and the current
7 content of the database 158. It is then be possible, in some cases, to automatically
8 modify the content of the autoprogramming tables, remove the outdated information
9 and replace it with the updated information so that the change is transparent for the
10 user. In other embodiments, a warning message can be displayed asking the user
11 to autoprogram the channel list again in the event such a change is detected.

12 While the invention has been described in conjunction with specific
13 embodiments, it is evident that many alternatives, modifications, permutations and
14 variations will become apparent to those skilled in the art in light of the foregoing
15 description. Accordingly, it is intended that the present invention embrace all such
16 alternatives, modifications and variations as fall within the scope of the appended
17 claims.

18 What is claimed is:
19
20